

## CHAPTER THREE

**Level-of-Service Standards**

State law requires that level-of-service standards be established as part of the Congestion Management Program (CMP) process.<sup>1</sup> Level of service must be measured by methods described in one of the following documents:

Transportation Research Board Circular 212, the latest version of the Transportation Research Board's *Highway Capacity Manual* (HCM), or a uniform methodology adopted by the CMA that is consistent with the *HCM*. The legislation leaves the choice of level-of-service measurement methodology to the CMA.

Level-of-service definitions generally describe traffic conditions in terms of speed and travel time, volume and capacity, freedom to maneuver, traffic interruptions, comfort and convenience, and safety. Level of service is represented by letter designations, ranging from LOS A to LOS F, with level-of-service A representing the best operating conditions and level-of-service F the worst. See Appendix C for graphic representation of level of service.

The purpose of setting level-of-service standards for the CMP system is to provide a quantitative tool to analyze the effects of land-use changes, and to monitor one system performance measure (i.e., congestion). If the actual system performance falls below the standard (i.e., congestion worsens to LOS F), actions must be taken to restore or improve level of service. Each year, the CMA is required to determine

how well local governments meet the standards in the CMP, including how well they meet level-of-service standards.

Each year since 1991, the CMA has contracted with a consultant to perform the necessary level-of-service monitoring for the entire CMP system. In 1998, the Board adopted a policy that level-of-service monitoring will be done every two years instead of annually. Based on this, the next monitoring study will be done in spring 2002. This has proven to be the most cost-effective approach and may continue.

Alternatively, if Caltrans assumes responsibility for monitoring the freeway system as required, or if the cities or county assume responsibility for monitoring local roads, evaluations will be structured to allow a self-certification process using Caltrans or local reports of level of service. The CMA will determine how well areas meet level-of-service standards based on these reports at the time of the annual conformance findings. The CMA will ensure that the adopted standards are monitored in a consistent manner by all local jurisdictions and/or Caltrans.

Local governments will need to consider the effects that their land-use decisions may have on the future level of service on the regional transportation system. Therefore, cities and counties may have to develop funding for projects and programs that will improve level of service on the CMP-designated system. If local land-use decisions make the level of service on

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<sup>1</sup> California Government Code Section 65089(b)(1)(A)

the state highway system worse, cities and the county may be responsible for the necessary improvements.

To provide a basis for more definitive strategies for maintaining level-of-service standards in subareas of Alameda County, the CMA has completed a program of corridor studies in the following high-priority corridors:

- I-80
- San Pablo Avenue
- I-880
- I-238
- I-580/Altamont Pass
- I-680

The CMA is participating in a number of corridor studies in high-priority corridors, including:

- I-580 Corridor BART to Livermore
- I-680 Value Pricing
- North I-880 Safety and Operations Study
- San Pablo and I-880 SMART Corridor programs

## LEVEL-OF-SERVICE STANDARDS

### Goals and Objectives

Level of service indicates traffic growth trends using vehicular volumes, capacity, and measurement of average speed and delay. The objectives are to develop an approach that is consistent and therefore replicable, easy to use, non-duplicative, and compatible with local government data and travel-demand models. The

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approach used is outlined in Table 4.

### Facility Classifications

The *HCM* provides methods for determining level of service on several types of facilities. These facilities are grouped into “interrupted-flow” and “uninterrupted-flow” facilities. Interrupted-flow facilities include city streets and surface highways (like State Route 123/San Pablo Avenue) that are part of the state highway system. For purposes of level-of-service analysis, the CMP system can be classified into three functional types of facilities: freeways, two-lane roadways and urban/suburban arterials. Each is described below:

### Freeways

These are uninterrupted-flow facilities, since traffic never stops (except during the most congested periods or when incidents occur). For the 1991 CMP, the CMA, in coordination with local jurisdictions, defined appropriate segments and performed the necessary floating car runs on the freeways to obtain travel speed data. This allowed the establishment of a baseline level of service for the system, including identification of segments operating at LOS F according to freeway travel speed criteria from the *HCM*. Systemwide level-of-service monitoring has been performed annually by the CMA using the network segments defined in 1991. It is anticipated that monitoring of the freeway system may ultimately be performed by Caltrans, as required by statute (Katz, Statutes of 1995).

**Table 4 — Approach to Levels of Service**

ISSUE	APPROACH
Interregional Trips	As defined by statute, “interregional travel means any trip that originates outside” Alameda County. A ‘trip’ means a one-direction vehicle movement. The origin of any trip is the starting point of that trip. In accordance with MTC guidelines, trips with no trip end in Alameda County (through trips) were not subtracted for monitoring reports.
Level-of-Service Standard	The level-of-service standard is E, except where F was the level of service originally measured, in which case the standard shall be F. The method of analysis is documented in “ <i>Establishing the Existing Level of Service for the Alameda County CMP-Designated Roadway System</i> ”. The methods employed constitute a uniform methodology adopted by the CMA that is consistent with the <i>Highway Capacity Manual (HCM)</i> . Methods described in Chapter 8 (Two-Lane Highways) and Chapter 11 (Urban and Suburban Arterials) of the <i>HCM</i> were the basis for establishing the level of service on the CMP system. They assess level of service on the basis of the average speed observed along a roadway segment (link speeds), or total volumes approaching an intersection (link volumes). These methods are not designed to replace the more detailed procedures that local agencies are likely to use for non-CMP purposes (such as local impact studies) which are typically concerned with an intersection’s ability to handle individual turning movements.
Monitoring	Level-of-service monitoring will be conducted by the CMA, although the cities, county or Caltrans may eventually assume responsibility for monitoring segments under their respective jurisdictions. State statute <sup>2</sup> requires Caltrans to monitor levels of service on the freeway system, unless the CMA designates that responsibility to another entity. Monitoring will be conducted biennially, recognizing that other surveys could be done for development impact studies (e.g., intersection turning movement counts). The method of data collection is the floating car technique of recording travel times between checkpoints based on actual travel time during the peak period. Data from several runs in all non-HOV lanes are averaged for each roadway segment.

<sup>2</sup> California Government Code Section 65089(b)(1)(A), Amended 1995.

### Two-Lane Roadways

These are uninterrupted-flow facilities. The criteria for inclusion of principal arterials in the CMP system specify a minimum of four lanes; therefore, two-lane roadways are not included as principal arterials. However, two-lane state highways are included, since all state highways must be in the system. These two-lane roads constitute a fairly small portion of the CMP-designated road system mileage, but a method for level-of-service analysis is suggested here. For two-lane roads without interruptions (signals or stop signs), Chapter 8 of the *HCM* is used, based on average travel speed.

### Urban/Suburban Arterials

These are multi-lane streets that have traffic signals spaced no more than two miles apart on average. Because of the emphasis in the CMP legislation on systems level planning, Chapter 11 of the *HCM* is used to estimate arterial level of service. The advantages include the need for relatively little input data, simple applied calculations and the results of explicitly determined levels of service (A, B, C, etc.). Following is a description of this method.

### Level-of-Service Methodology

Urban and suburban arterials are characterized by platoon flows. Operational quality is controlled primarily by the efficiency of signal coordination and is affected by how individual signalized intersections operate along the arterial. Level of service is primarily a function of travel speed along segments, and is calculated from field data. Beyond the measurement of existing level-of-service conditions (using actual counts or travel speed measurements), the Alameda County CMA's approach is to be forward-looking. Using the Alameda countywide travel model, future level-of-service conditions on the CMP system will be estimated by analyzing information about local land-use decisions and taking into account local investments

in transportation, which are proposed in the Capital Improvements Program of the CMP. Using the Countywide Model, it is possible to forecast average travel times and speeds for future traffic operations on these arterials. The results would need to be checked for reasonableness under existing conditions before being used as a forecasting tool.

### TRAFFIC MONITORING PROGRAM

Monitoring of level of service on CMP system roadways is presently conducted by the CMA. If the cities, county or Caltrans assume responsibility, monitoring could be accomplished through a self-certification process involving the local jurisdictions and/or Caltrans and the CMA. The following sections describe the process and provide guidelines.

#### Self-Certification Process

By June 15 of each year, a set of travel time runs would be submitted to the CMA for the CMP-designated routes. A city or the county, if it assumes responsibility, would submit the information, except for the freeways, within its jurisdictional limits. If Caltrans assumes responsibility for the freeways, it would similarly submit summary data to the CMA by June 15. Local jurisdictions or Caltrans will also be responsible for calculating levels of service according to Table 5, which is based on Chapter 11 of the *HCM*. Local agencies or Caltrans will keep raw field data available for examination by the CMA for at least three years. Travel time runs will be completed by mid-May each year. Technical guidance and assistance in reviewing methodology and interpreting level-of-service monitoring results will be provided by ACTAC.

#### Data Requirements

In addition to the basic geometric, signal timing, and other such "physical" information, the traffic monitoring program requires information

about average travel speed, which is the basis for level-of-service measurement on all facility types (i.e., freeways, two-lane highways (uninterrupted) and urban/suburban arterials).

For a given facility segment, monitoring must be performed and reported separately for each direction of travel. Travel speed studies normally are conducted using “floating” cars that drive at the posted (safe) speed, or if constrained by traffic conditions, at the average speed of traffic. All monitoring will be conducted during afternoon peak hours (between 4 p.m. and 6 p.m.).

### Acceptability of Data

A suggested approach to ensure monitoring that is acceptable to the CMA is described in *Establishing the Existing Level of Service for the Alameda County CMP-designated Roadway System* (CMA, 1991) which is based on the Institute of Transportation Engineer’s *Manual of Traffic Engineering Studies* (Chapter 7, Test Car Method). A test car is driven six times in each direction of all CMP-designated facilities. This frequency may be adjusted later for roadway segments that are found to consistently operate at LOS A or B. More than six test car runs are performed on roadway segments operating at LOS E and F because a greater range or fluctuation in data typically occurs. Test car runs will be repeated biennially.

The following guidelines will be used to determine acceptability of data for use in the CMP:

- Test car runs must be made on a Tuesday, Wednesday and/or Thursday, as these days will be most indicative of average weekday conditions.
- Test car runs on a particular segment must span a range of days and time of day. This means that test car runs should not be bunched on the same day of the week or taken on separate days at the same time.
- Runs near holidays, when school is not in session or when roadway construction is under way, must be avoided.
- Consistent monitoring periods must be observed for each roadway segment. For example, a comparison between April, 1994, and April, 1995, is likely to be more valid than a comparison between January, 1994, and August, 1995.
- If special generators are located within a few miles of the monitoring location, it must be determined whether unusual or unwanted activity levels are occurring at the special generator. A call to a shopping center management company, for example, could be made to ascertain that the test day(s) was reasonably close to average, and that no retailers were holding major sales.

**Table 5 — Relationship Between Average Travel Speed and Level of Service****LEVELS OF SERVICE FOR ARTERIALS**

<b>Arterial Class</b>	<b>I</b>	<b>II</b>	<b>III</b>
Range of Free Flow Speeds (mph)	35 to 45	30 to 35	25 to 35
Typical Free Flow Speed (mph)	40	33	27
<b>Level of Service</b>	<b>Average Travel Speed (mph)</b>		
A	≥ 35	≥ 30	≥ 25
B	≥ 28	≥ 24	≥ 19
C	≥ 22	≥ 18	≥ 13
D	≥ 17	≥ 14	≥ 9
E	≥ 13	≥ 10	≥ 7
F	< 13	< 10	< 7

**LEVELS OF SERVICE FOR FREEWAY SECTIONS**

<b>LOS</b>	<b>Average Travel Speed (mph)</b>	<b>Volume-To-Capacity Ratio</b>	<b>Maximum Traffic Volume (Vehicles / Hour / Lane)</b>
A	≥ 60	0.35	700
B	≥ 55	0.58	1,000
C	≥ 49	0.75	1,500
D	≥ 41	0.90	1,800
E	≥ 30	1.00	2,000
F	< 30	Variable-	

Source: *Highway Capacity Manual*, Transportation Research Board, 1985.

## Definition of Roadway Segments

For surface highways, route segments for travel time analysis have been determined by ACTAC, with input by the appropriate department (traffic engineer, planning department, etc.) at the local jurisdiction using the following guidelines:

- Segments should be at least one mile and not more than five miles in length.
- Logical segment break-points include: jurisdictional boundaries, points where the basic number of travel lanes change, locations where land-use changes occur (e.g., commercial area versus residential), points where the posted speed limit changes, or where the number of adjacent driveways is significantly different.

To date the CMA has performed all data collection (floating car runs) on the CMP-designated system of arterials and freeways. However, the CMA continues to work to ensure that the California Department of Transportation, Caltrans, will eventually assume responsibility for collecting all data necessary for determining levels of service on freeways. According to statute (Katz, Statutes of 1995), Caltrans “is responsible for data collection and analysis on state highways, unless the {CMA} designates that responsibility to another entity. The {CMA} may also assign data collection and analysis responsibilities to other owners and operators of facilities or services if the responsibilities are specified in its adopted program”.

## Identification of LOS F Roadway Segments

Between July and October, 1991, the CMA completed travel time studies to establish existing level of service on all segments of the CMP system during the p.m. peak period. The travel time studies were conducted on Tuesdays, Wednesdays, and Thursdays, between 4 and 6 p.m. The information gathered consisted of travel time runs on all CMP routes. A range of

four to ten travel time runs in each direction were done to estimate average travel speeds, in accordance with CMP requirements and Institute of Transportation Engineers recommendations, as specified in their *Manual of Traffic Engineering Studies*.

Travel time checkpoints for principal arterials were generally chosen at signalized intersections; for freeways, interchange ramp junctions were used. Further detail about segment level-of-service monitoring methodology and results are contained in reports that are available by contacting the CMA.

During the 1992 monitoring cycle it was determined that freeway-to-freeway connectors had not been monitored as part of the 1991 baseline level-of-service determination. Monitoring of these segments was performed, together with the rest of the network, between August and September, 1992. Five freeway connector segments were found to be operating at LOS F, and they were grandfathered as permitted by the statutes. The level-of-service freeway-to-freeway connections are shown in Table 6.

Tables 6 and 7 and Figure 8 identify the system segments (on freeways and principal arterials) found to operate at LOS F in 1991. According to the study results, a total of 15 freeway segments (excluding freeway to freeway connectors) and 15 arterial segments were operating at LOS F during the p.m. peak period in 1991. These segments, which operated at LOS F during 1991, the first year of the Congestion Management Program, are grandfathered from CMP requirements for preparation of a deficiency plan. However, the grandfather status does not exempt these roadways from analysis and mitigation for purposes of satisfying the California Environmental Quality Act or National Environmental Protection Act, as part of the Land-Use Analysis Program found in Chapter 6.

### **Frequency of Monitoring**

It is unlikely that a system segment will fall from LOS A to below E in just one year. To reduce calculation effort, traffic monitoring to comply with the CMP may be done only for segments in the LOS C or worse range, at the option of the local jurisdiction. Since a fair number of roadway segments operate at LOS A, it will be a poor use of limited resources to recalculate these levels of service every year. The focus should be on analyzing problem areas. Analysis of transportation impacts of proposed local land-use decisions will highlight segments, which may need to be monitored more closely. Thus, if a link is expected to be approaching LOS E or F, it will be monitored and its level of service analyzed more frequently than segments at better service levels.

### **COMPARISON WITH PREVIOUS RESULTS**

The results of several years of level-of-service monitoring, as presented in Table 8, show that overall traffic conditions for long-distance trips on the CMP freeway network have generally remained stable or improved. Though not particularly strong, an overall trend or change can be interpreted from comparisons with the 1991 level-of-service data. There is some improvement in average traffic conditions (i.e., higher speeds) on these longer distance freeway trips over 1991 conditions. However, there are still congested points found along most of the routes. System capacity and operational enhancements account for improvements on some facilities.

### **COMPLIANCE AND CONFORMANCE**

Government Code Section 65089.3(a) requires the CMA to biennially monitor conformance with the adopted CMP. Among the require-

ments, the CMA must find consistency with the level-of-service standards. If a roadway segment is not conforming to the level-of-service standards based on the biennial monitoring, the affected local jurisdiction will be notified, and may elect to remedy the level-of-service problem or prepare a deficiency plan (see Chapter 8). If after 90 days the local jurisdiction is still in non-conformance, the CMA is required to provide notice to the California Transportation Commission and the State Controller. The notice includes the reasons for the finding and evidence that the CMA correctly followed procedures for making the determination. The State Controller would then withhold the non-conforming jurisdiction's increment of subventions from the fuel tax made available by Proposition 111, and the jurisdiction will not be eligible to receive funding for projects through the federal Surface Transportation Program and Congestion Mitigation and Air Quality Program. If within the 12-month period following the receipt of a notice of non-conformance, the CMA determines that the city or county is in conformance, the withheld Proposition 111 funds will be released. If after the 12-month period the city or county has not conformed, the withheld Proposition 111 funds will be released to the CMA for projects of regional significance included in the CMP or a deficiency plan.



**LOCAL GOVERNMENT RESPONSIBILITIES**

At present, the CMA is contracting with a consultant to monitor all segments of the CMP roadway system. If a local government or Caltrans assumes responsibility for monitoring roadways included in the portion of the CMP system under its jurisdiction, it will be required to do the following:

- Biennially monitor the level of service on the designated system and report to the CMA by June 15 of each year relative to conformance with the adopted standards.

**Table 6 — Level-of-Service “F” Freeway Segments for Alameda County CMP-Designated Roadway System**

These segments, which operated at LOS F in 1991, the first year of the Congestion Management Program, are grandfathered from CMP requirements for preparation of a deficiency plan. However, being grandfathered does not exempt these roadways from analysis and mitigation for purposes of satisfying the California Environmental Quality Act or the National Environmental Policy Act or as part of the Land-Use Analysis Program.

*Legend:*

WB Westbound  
 EB Eastbound  
 SB Southbound  
 NB Northbound

**FREEWAY SEGMENTS**

	<b>Roadway Dir.</b>		<b>Limits</b>	<b>Jurisdiction</b>	<b>Average Speed (mph)</b>
1	I-80	WB	From: University To: I-80/580 Split	Berkeley/Emeryville	16.6
2	I-80	WB	From: I-80/580 Split To: Bay Brg Toll Plaza	Oakland	29.7
3	I-80	EB	From: I-580/80 Split To: University	Emeryville/Berkeley	25.8
4	I-80	EB	From: University To: Central	Berkeley/Albany	25.8
5	SR 24	EB	From: I-580 To: Fish Ranch Road	Oakland	28.5
6	I-580	SB	From: I-80/580 To: I-980/Hwy 24	Oakland	25.6\
7	I-980	EB	From: I-880 To: SR 24/I-580	Oakland	28.5
8	I-238	EB	From: I-880 To: I-580	County/San Leandro	29.8
9	I-880	SB	From: Hegenberger To: Washington	San Leandro/Oakland	29.2

	<b>Roadway Dir.</b>		<b>Limits</b>	<b>Jurisdiction</b>	<b>Average Speed (mph)</b>
10	I-880	SB	From: Washington To: A Street	County/Hayward	24.3
11	I-880	NB	From: Tennyson To: SR 92 (Jackson)	Hayward	18.2
12	I-880	NB	From: SR 92 To: Lewelling	Hayward	23.2
13	I-880	NB	From: Dixon Landing To: SR 262/Mission	Fremont	29.3
14	SR 92	WB	From: Clawiter To: Toll Gate	Hayward/County	27.1
15	SR 92	EB	From: Toll Gate To: I-880	Hayward/County	27.5

*Note:* Based on surveys taken during the p.m. peak period (4 p.m. to 6 p.m.) in September/October, 1992, unless otherwise noted.

#### **FREEWAY-TO –FREEWAY CONNECTOR**

<b>Ramp Connection</b>	<b>Jurisdiction</b>	<b>Length (miles)</b>	<b>Average Speed</b>	<b>Free Flow Speed</b>
I-80 SB to I-580 EB*	Oakland	0.30	18.7	45.0
I-580 WB to I-80 NB*	Oakland	0.21	16.0	45.0
I-680 SB to I-580 EB	Pleasanton	0.67	16.3	35.0
SR 13 NB to SR 24 EB	Oakland	0.35	14.4	45.0
I-580 WB; SR 24 WB to I-80 NB	Oakland	0.69	22.1	45.0

*Note:* Based on surveys taken during the p.m. peak period (4 p.m. to 6 p.m.) in September/October, 1992, unless otherwise noted.

\* Level-of-service condition was first reported during the 1991 surveys.

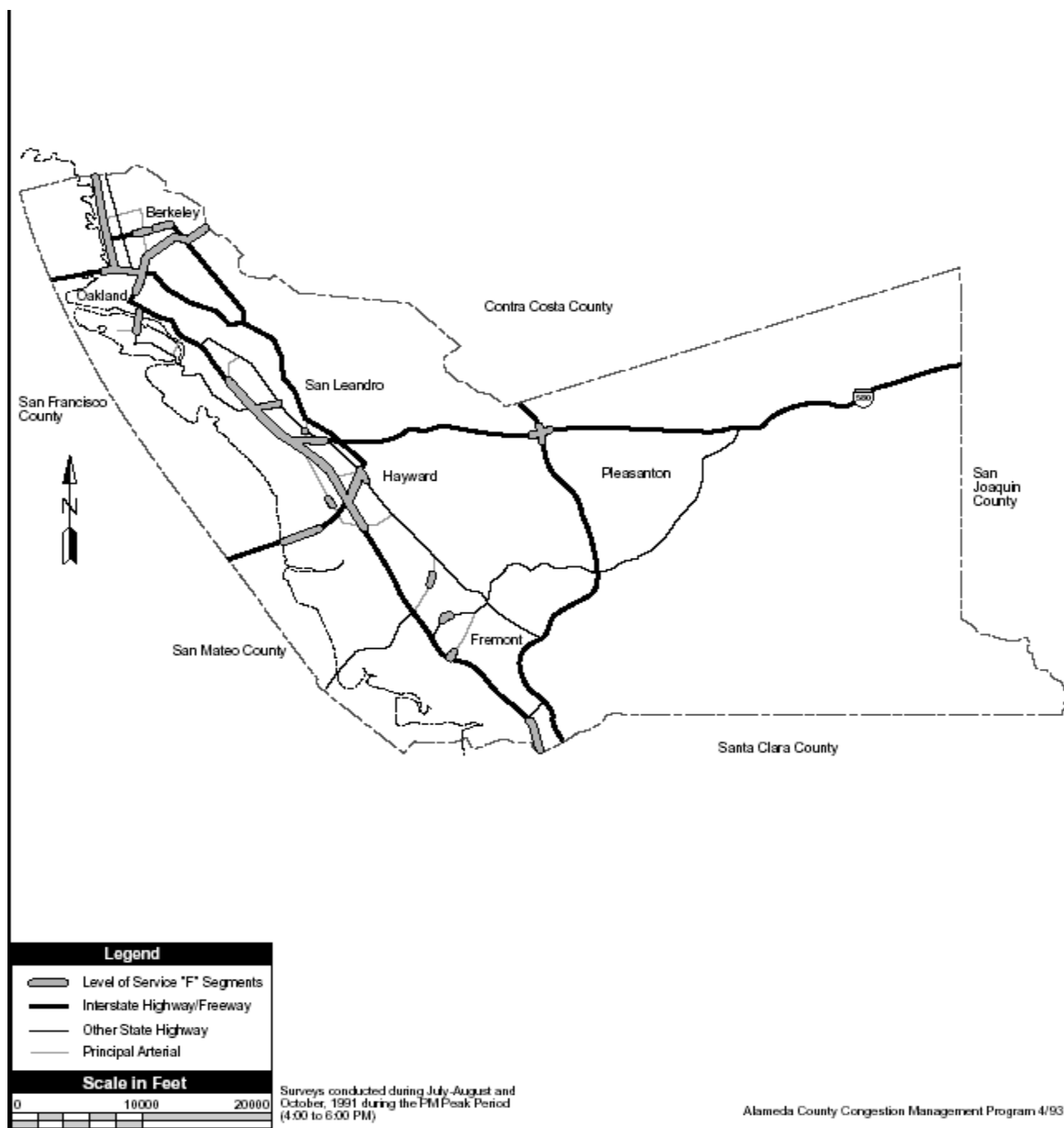
**Table 7 — Level of Service “F” Arterial Segments  
Alameda County CMP-Designated Roadway System**

	ROADWAY	DIR	LIMITS	JURIS	ARTERIAL CLASS	AVG SPEED (mph)
1	SR 13 - Ashby Ave.	WB	From: Telegraph To: Shattuck	Berkeley	III	8.7
2	SR 13 - Ashby Ave.	WB	From: Shattuck To: MLK, Jr Way	Berkeley	III	9.3
3	SR 13 - Ashby Ave.	EB	From: College To: Domingo	Berkeley	III	6.8
4	SR 123 - San Pablo Ave.	SB	From: Park Avenue To: 35th Street	Emeryville/ Oakland	II	9.4
5	SR 260	SB	From: 7th/Webster To: Atlantic	Oakland/ Alameda	I	12.3
6	SR 238 - Mission Blvd. NB		From: Sycamore To: Jackson	Hayward	II	8.8
7	SH 92 (Jackson St.)	EB	From: I-880 To: Winton	Hayward	II	8.6
8	SH 92 (Jackson St.)	EB	From: Winton Ave. To: Mission	Hayward	II	4.5
9	Hesperian Blvd.	NB	From: La Playa To: Winton	Hayward	I	11.1
10	Hesperian SB	SB	From: 14th St. To: Fairmont	San Leandro	II	9.9
11	Hesperian Blvd.	SB	From: Springlake To: Lewelling	Unincorp	II	9.6
12	SR 112 (Davis St.)	WB	From: I-880 To: San Leandro Blvd.	San Leandro	II	5.2
13	Decoto Road	WB	From: Union Square To: Alvarado-Niles	Union City	II	8.6
14	SR 84 (Fremont Blvd.) WB		From: Peralta Blvd To: Thornton Ave.	Fremont	II	7.2
15	Mowry Avenue	EB	From: I-880 To: Farwell Dr.	Fremont	II	9.6

*Note:* Based on surveys during the peak period (4 to 6 p.m.) in July-August and October, 1991.

**Table 8 — Level-of-Service Trends on the CMP-designated System (P.M. Peak Period)**

ROAD	DIR	LIMITS	DIST. (mi.)	MILES PER HOUR									
				'91 Aug	'91 Oct	'92	'93	'94	'95	'96	'97	'98	'00
I-80	EB	Bay Bridge Tollgate to Contra Costa line	6		23	20	21	22	20	21	21	20	27
I-80	WB	Contra Costa line to Bay Bridge Tollgate	6	26	25	24	22	23	28	25	25	28	18
I-580	EB	I-238 to I-205	31	-	56	55	55	55	50	55	na	na	41
I-580	WB	I-205 to I-238	31	-	57	56	55	57	56	61	na	na	55
I-580	EB	I-80 to I-238	16	-	53	52	49	44	48	53	42	60	63
I-580	WB	I-238 to I-80	16	-	58	55	56	51	50	52	54	61	63
I-680	NB	Scott Creek Rd. to Alcosta Blvd.	21	-	58	57	55	57	55	52	49	51	58
I-680	SB	Alcosta Blvd. to Scott Creek Rd.	21	-	59	58	57	55	56	61	56	67	63
I-880	NB	Dixon Landing Rd. to I-980	30	42	45	44	47	43	43	46	40	38	48
I-880	SB	I-980 to Dixon Landing Rd.	30	47	43	40	42	38	43	46	43	50	49
SR 13	NB	Mountain Blvd to Hiller Dr.	6	51	54	50	46	49	51	48	44	53	51
SR 13	SB	Hiller Dr. to Mountain Blvd	6	57	56	59	57	53	49	47	57	59	59
SR 24	EB	I-580 to Fish Ranch Rd.	5	29	30	29	30	30	29	24	30	39	33
SR 24	WB I-580	Fish Ranch Rd. to	5	53	54	58	53	54	58	50	48	60	57

**Figure 8 — Level-of-Service “F” Roadway Segments**

*Note:* These segments, which operated at LOS F in 1991, the first year of the Congestion Management Program, are grandfathered from CMP requirements for preparation of a deficiency plan. However, being grandfathered does not exempt these roadways from analysis and mitigation for purposes of satisfying the California Environmental Quality Act or the National Environmental Policy Act or as part of the Land-Use Analysis Program.